ORDER

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

6300.3

11 May 71

SUBJ: MULTIPLE RADAR DISPLAYS

1. PURPOSE. The purpose of this order is to provide information on multiple radar displays, method of obtaining this installation, and to prescribe how multiple radar displays shall be used.

2. DEFINITIONS.

a. Mosaic Display. A display on which the data from two or more radars are displayed simultaneously on the same cathode ray tube (CRT). A multiple radar display.

b. Overlap. The area of an RBDE display where the information from two or more radars is superimposed on the same display area.

c. Seam. The line on a mosaic display separating the areas of different radar coverage. Normally, it will be a broad strip indicating the area where both radars are displayed or overlapped.

d. Composite Display. A combination of radar data on one CRT display with data from two or more radars superimposed and presented in their relative geographic positions, including the existing overlapping area.

e. Split Screen. A display with information from two or more radars, each displayed in its discrete area. The seam will normally be overlapped into both areas.

f. Doughnut Display. A display using the output from two radars, usually a long-range radar and a short-range radar, combined such that the short-range data are displayed in the center and the long-range data are displayed in the outer area. The overlapped area may vary from a narrow circular seam to the full coverage of the short-range radar. This is generally used to provide better coverage in the area around the origin of the long-range radar or to provide extended range coverage.

g. Scan Converter Relative Linearity Error (SCRLE). The scan converter registration errors which occur when different displays are superimposed. They are caused by the relative differing linearities in scan converter equipments.

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RNMC/AF/AT-3; FAF-0 (minimum)
FAT-1, 2, 4, 8 (minimum)

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h. Slant Range Difference (SRD). For the purpose of this Order it is the difference between the ground range to the mosaic seam and the slant range to a point on the seam equal to the highest altitude for which the display will be used.

i. System Errors (SE). Those radar errors involved with range and azimuth measurement of an aircraft. They are a function of the accuracy of the radar, the radar remoting and portions of the display system.

3. BACKGROUND.

a. Through the efforts of the SRDS and several air route traffic control centers (ARTCCs), a relatively simple but effective modification has been designed which permits the display of multiple radar systems on a single display. It is limited to radar bright display equipment models 4 and 5 (RBDE-4 or 5) only. The basic system is intended for use as a two-radar presentation although more than two may be displayed simultaneously. Many variations, such as vertically or horizontally straight split, skewed angle split or an infinitive assortment of curved, odd-shaped splits to serve operational requirements, may be established.

b. There appear to be many advantages in establishing a multiple radar display. As an example, the increase of supersonic aircraft operating above Flight Level 600 (F-12, R-71, etc.) in the California area prompted the Los Angeles Center to combine three of their long-range radar systems on one display and thereby provide them with excellent coverage of practically their entire area. It is believed that many ARTCCs may be able to use the multiple radar display technique to obtain operational benefits and economical savings; e.g., combining sectors during periods of very light activity, improved handoff procedures, etc.

4. SCOPE. Pending the establishment of National Airspace System centers, wherein mosaic techniques will be an integral part of the total system, ARTCCs may employ the techniques and equipment modifications for mosaic displays to satisfy specific needs. However, in view of the interim nature of the mosaicking techniques referred to in this Order, the expenditure of funds above those required for the procurement of RBDE-4 and 5 mosaic generator modification kits cannot be justified. Accordingly, with the exception of installation hardware, implementation of the techniques and procedures herein must be accomplished by using equipment in the existing authorized inventories. No degradation to the present spare ratio of equipment (Order 6410.8 CRITERIA for On-Site Maintenance Radar Bright Display Equipment and Monitors (RBDE-3, RBDE-4, RBDE-5, RBDE-5A)) or any present maintenance system monitoring shall be allowed by the introduction of multiple radar displays.

5. EQUIPMENT.

a. Modification Kits and Technical Data. Multiple radar displays shall be configured either as composite, doughnut, or split screen types only. Agency approved installation and alignment instructions will be published for all three types; however, RBDE-4 and RBDE-5 equipment installation hardware is required only for the split screen and doughnut type displays.

b. Implementation. Facilities which plan use of a multiple radar display shall conduct a thorough study to determine what improvements in air traffic control service and efficiency in facility operation will be obtained. When a need is identified, a request shall be submitted to the Region. Upon obtaining regional approval, the modification shall be installed in accordance with the provisions of this Order and a special flight check shall be conducted to determine the degree of possible alignment error in the overlap area between the radar systems. The results of this flight check shall be forwarded through the Region to the Air Traffic Service for a determination as to the need for establishing special procedures for that specific multiple display. Final approval for operational utilization will be made by Air Traffic Service. In the interim period pending final approval, the multiple radar display may be utilized for training controllers in the use of the display and for providing radar services to aircraft; but during this period radar separation standards shall not be applied unless the target returns for both aircraft are displayed by the same radar source.

6. PROCEDURES.

a. General.

(1) The use of mosaic techniques introduces a consideration not found in a single radar display. It is called scan converter relative linearity error. Additionally, two other factors, one of which is inherent to all radars and the other which could exist must be considered. These are slant range displacement and system error, respectively. The variables associated with these factors preclude on-the-spot application by controllers. The mosaic techniques, however, do not affect the relative position of targets to be separated when using returns from the same radar system.

(2) Because of the importance of maintaining proper alignment by observing the returns of a single aircraft as displayed by the different radar sources, it has been determined that an overlap area must be used for all analog mosaic applications thereby providing correlated targets within the overlap area. (As used in this Order, correlated targets mean that the returns are at least touching.)

b. Overlap Area.

(1) The following procedures apply only to a split screen or "doughnut" mosaic and not to a composite display which provides full overlapping coverage.

(2) The minimum width of the overlap is determined by totaling the SCRLE, SRD, and SE values for each radar involved and doubling the largest total obtained. Although SCRLE is the only factor which is unique to multiple radar displays, SRD always affects the returns of two opposing radars to some degree and the SE factors of two radars may accumulate in the same direction. The SCRLE value is computed by taking one percent of the display diameter for each radar involved. In determining the value for slant range difference, the shortest distance from the radar source to the seam boundary is measured and the corresponding SRD for the highest altitude to be used is found in the table in Appendix 1. Three percent (3%) of the greatest distance from the radar source to the seam boundary is used for determining the value for system error.

(3) Example. Determine the minimum width of seam boundary to be used for combining radars A and B on a 200-mile diameter display below FL 240.

Radar A values	Radar B values
a. SCRLE =2.0 200 NM @ 1%	a. SCRLE =2.0
b. SRD = .2 Assume Distance from radar source perpendicular to seam boundary 50 NM; altitude consideration 0 to FL 240 (Table Appendix 1)	b. SRD = .16 Assume Distance from radar source to seam boundary 70 NM
c. SE =2.7 Assume Distance from radar source to maximum point along seam boundary to be 90 NM 3% of 90 NM	c. SE =3.0 Assume Distance from radar source to maximum point along seam boundary to be 100 NM 3% of 100 NM
4.9 NM	5.16 NM

Therefore, the minimum width of the overlap area should be 11 NM (twice the larger value rounded off to the next highest whole number).

c. Multiple Radar Display Alignment Criteria. Multiple radar displays may be used for air traffic control only when the following conditions are satisfied.

(1) Proper alignment of data between different radar sources has been verified through the observance of a correlated target (as defined by paragraph 6a(2), page 4) within the overlap area. This verification must be continuously reconfirmed by the controller during the use of the display.

(2) Periodic observation of the video map, the radar source sweep origins, fixed targets, and range marks confirms that no shift in azimuth orientation or sweep ranges has occurred.

(3) The alignment of the individual scan converter write or read linerarity shall be accomplished by obtaining registration of the respective radar video maps only, and not by misalignment of sweep linerarities to obtain "correlated targets" by compensating for slant range errors. This procedure will assure that the read and write sweep linerarity of the individual scan converters are correct for the plane of reference that was used to draw the video map, and also correct with respect to surveyed permanent radar echoes and current flight check.

(4) The overlap area on a multiple radar display shall not be less than the width as defined in paragraph 6b of this Order to permit the application of the separation standards defined in Controller Handbooks 7110.8B and 7110.9B.

d. Separation Minima. Standard radar separation shall be applied on multiple radar displays only when the alignment criteria in c above is confirmed--if not, both aircraft involved must be displayed by the same radar source.

7. TRAINING. Normally, a controller becomes technically capable of handling a multi-video display if he is provided a minimum of four hours of training by an airway facilities technician in the equipment room learning how the display is put together. During this period, the technician should demonstrate what problems require technical correction and what the controller can do to maintain an

adequate display by using sector controls. After equipment orientation, a minimum of twelve hours of operational orientation (OJT) should be provided to ensure a satisfactory degree of proficiency is attained. Emphasis must be placed on the capability of a controller to recognize occasional alignment shifts and his ability to take proper corrective action. When the instructor and the trainee's crew chief are satisfied with the degree of proficiency attained, an appropriate entry should be made in the controller's training record.

8. FUNDING. Provisions of this Order shall be implemented through normal budgetary procedures.

J. H. Shaffer
Administrator

APPENDIX 1. SLANT RANGE DIFFERENCES

ALTITUDE IN THOUSANDS OF FEET

GROUND RANGE	5	10	15	20	25	30	35	40	45	50
5	0.07	0.27	0.58	0.99	1.48	2.03	2.68	3.27	3.94	4.63
10	0.04	0.14	0.30	0.53	0.82	1.16	1.55	1.98	2.45	2.96
15	0.02	0.09	0.21	0.36	0.56	0.80	1.08	1.39	1.74	2.12
20	0.02	0.07	0.16	0.28	0.43	0.60	0.83	1.07	1.35	1.65
25	0.02	0.06	0.13	0.23	0.35	0.50	0.68	0.87	1.10	1.35
30	0.02	0.05	0.00	0.19	0.30	0.42	0.57	0.74	0.93	1.14
35	0.01	0.05	0.10	0.17	0.26	0.37	0.45	0.65	0.81	0.99
40	0.01	0.04	0.09	0.15	0.23	0.33	0.40	0.58	0.72	0.88
45	0.01	0.04	0.08	0.14	0.21	0.30	0.37	0.52	0.65	0.80
50	0.01	0.04	0.08	0.13	0.20	0.29	0.35	0.48	0.60	0.73
55	0.01	0.04	0.07	0.12	0.19	0.26	0.33	0.44	0.55	0.68
60	0.01	0.04	0.07	0.12	0.18	0.25	0.31	0.42	0.52	0.63
65	0.01	0.04	0.07	0.11	0.17	0.23	0.30	0.39	0.49	0.59
70	0.01	0.04	0.07	0.11	0.16	0.22	0.29	0.37	0.46	0.56
75	0.01	0.03	0.07	0.11	0.16	0.21	0.28	0.36	0.44	0.54
80	0.01	0.03	0.07	0.10	0.15	0.21	0.27	0.34	0.43	0.52
85	0.01	0.03	0.06	0.10	0.15	0.20	0.26	0.33	0.41	0.50
90	0.01	0.03	0.06	0.10	0.15	0.20	0.26	0.32	0.40	0.48
95	0.01	0.03	0.06	0.10	0.14	0.19	0.25	0.32	0.39	0.47
100	0.01	0.03	0.06	0.10	0.14	0.19	0.25	0.31	0.38	0.45
105	0.01	0.03	0.06	0.10	0.14	0.19	0.24	0.30	0.37	0.44
110	0.01	0.03	0.06	0.10	0.14	0.19	0.24	0.30	0.36	0.43
115	0.01	0.03	0.06	0.10	0.14	0.18	0.24	0.29	0.36	0.43
120	0.01	0.03	0.06	0.10	0.14	0.18	0.23	0.29	0.35	0.42
125	0.01	0.03	0.06	0.10	0.14	0.18	0.23	0.29	0.35	0.41
130	0.01	0.03	0.06	0.10	0.14	0.18	0.23	0.28	0.34	0.41
135	0.01	0.03	0.06	0.10	0.14	0.18	0.23	0.28	0.34	0.40
140	0.01	0.03	0.06	0.10	0.13	0.18	0.23	0.28	0.34	0.40
145	0.01	0.03	0.06	0.10	0.13	0.18	0.23	0.28	0.33	0.40
150	0.01	0.03	0.06	0.10	0.13	0.18	0.22	0.28	0.33	0.39
155	0.01	0.03	0.06	0.10	0.13	0.18	0.22	0.28	0.33	0.39
160	0.01	0.03	0.06	0.10	0.13	0.18	0.22	0.27	0.33	0.39
165	0.01	0.03	0.06	0.10	0.13	0.18	0.22	0.27	0.33	0.39
170	0.01	0.03	0.06	0.10	0.13	0.18	0.22	0.27	0.33	0.38
175	0.01	0.03	0.06	0.10	0.13	0.18	0.22	0.27	0.33	0.38
180	0.01	0.03	0.06	0.10	0.13	0.18	0.22	0.27	0.33	0.38
185	0.01	0.03	0.06	0.10	0.10	0.18	0.22	0.27	0.33	0.38
190	0.01	0.03	0.06	0.10	0.13	0.18	0.22	0.27	0.32	0.38
195	0.01	0.03	0.06	0.10	0.13	0.18	0.22	0.27	0.32	0.38
200	0.01	0.03	0.06	0.09	0.13	0.18	0.22	0.27	0.32	0.38

GROUND RANGE & SLANT RANGE DIFFERENCE IN NAUTICAL MILES